Consommation et Corporations Canada
Consumer and Corporate Affairs Canada

Bureau des brevets
Patent Office

Ottawa, Canada
K1A 0C9

(11) (C) **1,303,377**

(21) 572,181

(22) 1988/07/15

(45) 1992/06/16

(52) 72-71

(51) INTL.CL.[5] E04B-2/86; E04G-9/05

(19) (CA) **CANADIAN PATENT** (12)

(54) Process for the Production of a Formwork Assembly and a Formwork Assembly Produced Thereby

(72) Krecke, Edmond D. , Germany (Federal Republic of)

(73) Ipa-Isorast International S.A. , Panama

(30) (DE) Germany (Federal Republic of) P3723341.6 1987/07/15

(57) 33 Claims

5724A

ABSTRACT OF THE INVENTION

In processes for the production of a formwork assembly for casting concrete structures, side wall portions of the assembly are interconnected by connecting members which are produced by applying mortar, with the use of a bonding agent, to the inward side of the wall portion in openings in a template. A bell-shaped or disc-shaped casting mould filled with moist concrete is then turned over on to the mortar, being located in the correct position by the openings in the template. The respective halves of a formwork assembly produced in that way may be stacked with the interposition of thin plates and can be subsequently joined, for example by adhesive means. Modified forms of the process use dumbbell-like connecting members produced by means of axially divided mould portions, optionally with interposed separator between the co-operating portions.

The present invention relates to a process for the production of a formwork or shuttering assembly for the encased concrete construction system and a formwork assembly produced thereby.

The encased concrete construction system involves using large-size formwork or shuttering components of hard foam material which are provided at their edges with grooves and tongues for securing them in position relative to each other and which in their interior have connecting members between the side walls of the formwork assemblies, for carrying the forces which occur when the concrete is being cast in the interior of the assemblies. Assemblies of that nature are disclosed for example in German published specification (DE-AS) No 26 18 125 and German laid-open application (DE-OS) No 34 05 736. The connecting members used in such assemblies include connecting members of a generally dumbbell-like configuration made of concrete, having two mutually oppositely disposed flanges and an intermediate portion interconnecting the flanges. The free end surfaces of the flanges are provided with grooves and tongues which are fitted into corresponding tongues and grooves provided on the inwardly facing side surfaces of the side wall portions of the respective formwork assemblies. When the formwork assemblies are filled with concrete, the connecting members are homogeneously integrated into and thus form an integral

structure with the concrete introduced into the assembly. Unlike formwork assemblies which use connecting members made of metal, such a construction in which the connecting members are made of concrete does not give rise to a thermal bridge effect between the side wall portions of the formwork assemblies. Furthermore, in comparison with formwork assemblies using connecting members consisting of hard foam material which are for example formed in one piece with the side wall portions of the assemblies, the construction using connecting members made of concrete substantially eliminates the formation of a sound bridge effect and also the possibility of fire striking through the formwork assembly, in the region of the connecting members. In addition, the comparatively heavy connecting members, since they are made of concrete or like material, ensure that the formwork assemblies cannot so-to-speak float up on the surface of the light-weight concrete as it is introduced into the shuttering or formwork arrangement. The weight of the connecting members produces a substantial pressure force as between the edges, which are in mutual contact, of the formwork assemblies which are stacked one upon the other in the formwork construction, and that pressure force causes the gaps between the formwork assemblies to be satisfactorily closed off so that the cement grout which is important

from the point of view of the setting process cannot run out. Furthermore the weight of the connecting members provides that the formwork structure has a high level of rigidness and stability, for example in the event of a storm occurring.

The dumbbell-like connecting members made of concrete are cast in one piece separately from the side wall portions of hard foam which make up the sides of the formwork assembly, and are then fitted into or engaged into or secured by adhesive means in the inward grooves provided by the inwardly facing side surfaces of the side wall portions of the respective formwork assemblies. That operation may be carried out subsequently in the factory or on the building site itself. The dumbbell-like connecting members may also be produced by separately casting two halves which are then later connected together by way of intermediate portions in the form of eyes, hooks, wires, bars or screws, as for example in German laid-open application (DE-OS) No 36 01 878.

While formwork assemblies of the above-indicated kinds have proved to be generally successful, the production thereof however is comparatively expensive and requires a great deal of space and time by virtue of the length of the period required for the concrete parts of the connecting members to set.

According to the present invention there is provided a process for the production of a formwork assembly for the encased concrete construction system, the assembly comprising first and second wall portions and a connecting member of concrete or concrete-like material for interconnecting the wall portions, the connecting member being of a generally dumbbell-like configuration providing flange means for fixing to the mutually opposite disposed wall portions and an intermediate portion between the flange means, including the following steps:

a) a template having openings corresponding to the shape of the flange means is applied to the inward side of a said wall portion,

b) a flowing mortar is introduced into the openings and smoothed off, a bonding agent matched to the material of the wall portion providing for joining the mortar to the wall,

c) moulds corresponding to the flange means to be produced, with their flange-defining opening upwardly, are filled with damp concrete and smoothed off,

d) the moulds are turned over with their flange-defining opening on to the mortar in the openings in the template, and

e) the moulds and the template are removed.

In another aspect the present invention provides a

formwork assembly produced by a process as set forth in the immediately preceding paragraph wherein at least one said wall portion comprises a hard foam material.

As in the process according to the invention as defined hereinbefore the connecting members are cast directly on the wall portions of the formwork assemblies, there is no need for separate production thereof. Using the flowing or float mortar with a suitable bonding agent makes it possible to produce an extremely good and permanent connection which is capable of withstanding tensile stresses, to the wall portions of the formwork assembly. The bonding agent may easily be added to the mortar but it is also possible for the bonding agent to be applied to the wall portions, at least in the region of the openings in the template, for example by spraying or by painting it on, in the form of a coating. The bonding agent may also be applied to the wall portions of the assembly by dipping the wall portions into a suitable bath.

In accordance with another preferred feature, a colouring agent may be added to the bonding agent in order thereby to ensure that, particularly when using hard foam material for the wall portions of the assembly, the otherwise snow-white exterior is covered over by the colouring effect. A bright white appearance of that kind

causes a great deal of trouble in particular under conditions of bright sunshine, and may result in complaints similar to that known as snow blindness.

In accordance with another preferred feature of the invention, it is possible for the freshly produced wall portions to be stacked one upon the other in order to permit the concrete to set fully and for storage purposes, so that the amount of space required for production and storage of the formwork assemblies can be substantially reduced. For that purpose, the finished wall portions are laid out in a layer on a generally flat surface, with the flanges on the wall portions being on the top side thereof, then a layer of thin plates such as for example plywood panels, is laid on the flanges of the connecting members, and then a further layer of wall portions is laid on the intermediate plates. Those steps can then be repeated so as to form stacks which may be several metres in height. After each layer has been formed, the concrete of the connecting members at the beginning of the layer has set to such an extent that, when the next following layer is laid out in position on the thin intermediate plates, the connecting members are no longer subject to any risk of deformation. The respective adjoining layers of wall portions, for that purpose, must be of a given length so that a sufficient period of time elapses before the next following layer is

set in position upon the intermediate plates disposed on the previously formed layer. Prior to the wall portions being formed into a stack in that way, the free ends of the flanges on the respective wall portions are set to a predetermined height, for example by means of a template which may be for example of a bridge-like configuration, as by scraping off or removing a small amount of material to provide the correct height setting or by slightly pressing on the ends of the flange portions. The formwork assemblies which are subsequently formed therefrom are then all of a highly accurate uniform configuration, with very precise inside and outside dimensions.

In accordance with further preferred features of the invention, the connecting members may be in a wide range of different shapes and sizes. The flanges are preferably of a circular configuration but they may also be oval, rectangular or square. The moulds in which the concrete is cast may be of a generally bell-shaped configuration in such a way that a stem portion adjoins the respective flange. For the purposes of connecting two wall portions to provide a formwork assembly, the free ends of the stem portions are then secured together as by adhesive means. Using a simple form of equipment, it is possible in that operation to ensure that the ends of the stem portions meet accurately, to provide an accurate formwork assembly. Prior to the material setting, at least one groove-like depression may be

formed, at the transition between a respective flange and the stem portion, to act as a subsequent mounting location for a reinforcing rod or bar, for example by such a rod or bar being pressed into position therein.

However the mould for producing the flanges may also be of such a configuration as to produce a flange which is of a generally disc-like configuration. That flange is provided with a central depression which is preferably of a circular cylindrical configuration, and, for the purposes of connecting first and second wall portions together to provide a formwork assembly, intermediate portions of a rod-like configuration are then secured by adhesive in respective mutually oppositely disposed depressions in the wall portions, acting as a connecting element. By varying the length of the respective intermediate portions, it is possible to adjust the internal dimension of the formwork assembly and thus the thickness of the concrete wall which is subsequently cast therein. The intermediate portion may advantageously be made from concrete by means of a cylindrical hollow mould. Prior to the material being set, groove-like depressions may be formed in the region of the two ends thereof, to act as a subsequent mounting location for reinforcing rods or bars.

Another preferred feature of the invention provides that extended fixing means such as reinforcing rods or bars, hooks, eyes, screws, wires, metal strips and the like

may be embedded into the flange or into the adjoining stem portion, prior to setting of the material. In the same fashion bores may be pressed into the flange by means of a suitable tool such as, in its basic form, a peg or pin, with the bores serving as mounting locations for subsequently fitting extended fixing means.

The uniform spacing between the connecting members, of for example 25 cm, which is produced by virtue of using the templates, provides a given dimensional pattern in that the connecting members occur at specific intervals in the formwork structure formed by the formwork assemblies. Although it is possible to saw through the formwork assemblies between the connecting members, on the actual building site, it is not possible to saw through the assemblies at the locations of the actual connecting members themselves. In accordance with a further preferred feature of the invention, that restriction can be overcome by providing that fitted into the moulds for producing the flanges and possibly the stem-like intermediate portions are central plates which extend along the axis of the connecting members and in the direction of the height of the formwork assembly. The finished formwork assembly can then be cut off parallel to and in line with the respective separating plates so that it is then possible to use what might be termed half a formwork assembly, that is to say a

forkwork assembly which has been cut to length at a location precisely centrally of a connecting member therein. As generally a formwork assembly has to be cut to length in that way only in the region of the respective ends thereof, in a preferred aspect of this feature the separating plates are used only in relation to the flanges or stem-like intermediate portions, which are those that are adjacent to the respective ends of the wall portions of the assembly.

As noted above, in the formwork assemblies produced by the process in accordance with this invention, at least one wall portion of the formwork assembly comprises hard foam material, but generally both wall portions and any end wall portions that may be used comprise hard foam material. It is also possible however for a wall portion of a formwork assembly to be produced from gypsum, light-weight gypsum, gypsum-cement concrete, clay or like material. That wall then subsequently forms the inward side of the concrete wall which is cast by means of a plurality of such formwork assemblies, thus substantially preventing the undesirable transmission of sound along the concrete wall. In addition such a wall does not produce a hollow sound when it is tapped or struck.

It will be appreciated that the process according to the invention makes it possible to produce formwork assemblies from smooth plates which are cut from a block.

However, in order to enhance the holding force as between the flanges of the connecting members and the side wall portions of the respective formwork assemblies, it is also possible for the inward side of the wall portions to be provided with a tongue-and-groove configuration, with the grooves preferably having undercut configurations for improved anchoring of the flanges therein. The cross-sectional shape of the grooves may be selected according to the particular requirements involved in any given situation, for example in the shape of a dovetail, an open semicircle or full circle, or some other configuration. The wall portions may also be provided with retaining grooves on the top side and at the ends.

Fixing wires may be cast into the flanges, in accordance with another preferred feature of the invention. The wires may then be drawn from both sides through a tubular intermediate portion which is provided with edge openings or bores at both ends. The wires are then guided outwardly through the bores and are then twisted together in a tensioned condition. In that way the formwork assemblies may be easily made up on site, according to the respective requirements involved. Different wall thicknesses may be produced by using intermediate portions of different lengths.

End parts for closing off the formwork assemblies at the end of a wall or at a corner construction are

advantageously adhesively joined to the ends or between the ends of the wall portions of the formwork assemblies. In that case, in order to provide for improved stability at for example window and door openings, the end parts of a plurality of formwork assemblies which are disposed in superposed relationship may form a unitary continuous plate or panel structure.

Because of the strong connection between the flanges and the wall portions of the formwork assemblies, the wall portions, at least in the region of a flange, may be provided with a slot which extends from top to bottom thereof. The width of the slot may be in the region of half the diameter of a flange. The slot which can also be subsequently sawn out on site ensures that, at wall junctions or corner connections, the concrete of the respective elements continuously merges one into the other without interruption by a hard foam wall portion. That increases the strength of the structure and contributes to eliminating sound bridges and the risk of fire striking through the wall construction.

Embodiments of a process and a formwork assembly according to the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view of production of the wall portion of a formwork assembly by the process

according to the invention,

Figures 2a to 2d diagrammatically show the individual steps in the process illustrated in Figure 1,

Figure 3 shows the stacking of wall portions of formwork assemblies produced by the process shown in Figures 1 and 2,

Figure 4 is a side view of an embodiment of a formwork assembly according to the invention,

Figure 5 is a side view of a further embodiment of a formwork assembly according to the invention,

Figure 6 is a view in cross-section of a divided casting mould for the flange of a connecting member of a formwork assembly according to the invention,

Figure 7 is a diagrammatic view of the possibility of dividing up a formwork assembly at different locations,

Figure 8 is a side view of yet another embodiment of a formwork assembly according to the invention,

Figure 9 is a side view of still a further embodiment of a formwork assembly according to the invention,

Figure 10 shows a corner connection with a continuous run of concrete in the join, and

Figure 11 shows a wall junction with a continuous run of concrete in the connection.

Reference will first be made to Figures 1 and 2 showing the individual steps of a process for the production

of a formwork or shuttering assembly.

Reference numeral 1 denotes a side wall portion forming part of a shuttering assembly which is made up from two such side wall portions. Fitted on to the wall portion 1 is a template 2 which comprises a suitable material such as a plastic material or metal. Locating pins 3 ensure that the wall portion 1 and the template 2 are in an accurately defined positional relationship, on for example a workbench or like surface. The wall portion 1 comprises for example hard foam.

Unlike the wall portion 1 shown in Figure 1, the wall portion 1 shown in Figure 2 has a plurality of grooves 4 of dovetail-shaped cross-section. However, as indicated above, the grooves 4 are only an additional and preferred feature of the invention and do not necessarily have to be provided.

The template 2 has a plurality of openings 5 which as illustrated are of a circular configuration and which are at uniform spacings from each other, defining the dimensional pattern of the connecting members to be formed by means thereof. The openings 5 may be of different shapes, they may be at non-uniform spacings from each other and they may be disposed at eccentric locations. After the template 2 has been laid on to the wall portion 1, the arrangement is in the configuration shown in the region of an opening 5, in Figure 2a. A flowing or float mortar 6 which includes a bonding agent matched to the material of the wall portion 1

is then introduced into the respective openings 5 and the mortar is then smoothed off. That results in the condition shown in Figure 2b, and also the condition shown in relation to the two openings 5 at the right-hand side in Figure 1.

It will be noted that, instead of being mixed with the mortar, the bonding agent may also be applied to the wall portion in the form of a coating, at least in the region of the openings 5, or it may be applied for example by dipping. The bonding agent may also be coloured.

Subsequently or in parallel with that step in the process, which results in the configuration shown in Figure 2b, a casting mould 7 which is of a generally bell-shaped configuration is filled with concrete 8 which is damp or moist, with a generally low water content. The mould is filled when its large mouth opening is facing upwardly, being therefore in an inverted position relative to the position thereof shown in Figure 2d. In that way the concrete 8 can be easily and conveniently introduced into the mould 7.

The mould 7, with the concrete 8 which is still in a moist condition, is then turned over and applied to the mortar 6 in a respective opening 5. The edge of the mould 7 is received by the respective opening 5 so as to ensure that the mould 7 is precisely located relative to the opening 5, as shown in Figure 2c. The mould 7 may then be removed,

possibly with the assistance of a slight shaking or knocking effect to provide for easier release of the mould 7 from the concrete 8, and subsequently the template 2 may also be removed, giving the configuration shown in Figure 2d.

The wall portions 1 with the connecting member halves formed thereon, which are indicated by reference numeral 10 in Figure 3 and which consist of the concrete 8 and the mortar 6, are arranged in a row in juxtaposed relationship, as shown in Figure 3, on an at least generally flat surface, for example the concrete floor of a building, forming rows of lengths of between 10 and 30 metres or even more. When one layer of a plurality of rows of such elements is finished, then, to protect the fresh connecting member halves 10, thin plate members 11 which may be for example plywood panels or panel members of another material, measuring for example 100 x 200 x 0.3 cm, are laid in position on the connecting member halves 10. The next layer of connecting member halves 10 is then set in position on the plate members 11. In that way it is possible to produce a stack which is for example from 2 to 3 metres in height. In each case it is only necessary to allow a sufficient period of time to elapse for the concrete 8 of the connecting member halves 10 to become so firm that they can carry the loads imposed thereon by the superposed layers of connecting member halves 10.

Reference will now be made to Figure 4 showing in diagrammatic form the way in which two wall portions 1 of a formwork assembly with connecting member halves 10 are subsequently fitted together to provide a formwork assembly by the end faces of the halves 10 being secured together by adhesive. The use of a simple piece of equipment (not shown) ensures that the end faces of the halves 10 meet accurately to provide an accurate formwork assembly. That then provides the generally dumbbell-like connecting members 20 which are each formed from first and second halves 10, each connecting member 20 having first and second flanges 12 and an intermediate portion 13 interconnecting same, the intermediate portion 13 being of a generally stem-like configuration in the illustrated embodiment.

In the embodiment shown in Figure 5, the process for the production of the connecting member halves involved using a mould (not shown) which, differing from the mould 7 shown in Figure 2d, is in the form of a shallow dish or bowl, thus only resulting in flanges 22 which have a central depression as indicated 14. When two wall portions 1 with flanges 22 are assembled, stem-like intermediate portions 23 are then fitted into the depressions 14 and secured therein for example by adhesive.

In the two embodiments shown in Figures 4 and 5, the intermediate portions 13 and 23 respectively were provided

in the region of their transition with the flanges 12 or 22 respectively, prior to setting of the concrete with groove-like depressions as indicated diagrammatically at 15 in both Figures 4 and 5, for subsequently serving as mounting locations for for example reinforcing rods or bars (not shown).

Referring now to Figure 6, shown therein is a casting mould 17 which substantially corresponds to the mould 7 shown in Figure 2d but which in addition has a central separating plate 16. The connecting elements halves which are produced with the mould 17 shown in Figure 6 are of the same shape as the halves 10 but they are divided into two parts so that subsequently a formwork assembly produced by means of wall portions 1 bearing such connecting members may be divided up at that location, for example by sawing, as shown diagrammatically by the broken line shown at 18 in Figure 7. Therefore, in addition to separating the formwork assembly between respective connecting members 20, in the region indicated by the broken lines 19, in accordance with the dimensional pattern predetermined by the spacing of for example 25 centimetres between adjacent connecting members 20, it is possible for the formwork assembly to be cut up at half the dimensional pattern referred to above, thereby permitting the formwork assembly to be easily adapted to the respective structural requirements on a given site.

Figure 8 shows another embodiment of a formwork assembly according to the invention, which once again comprises flanges 22 corresponding to those shown in Figure 5 with a central depression 14, with the flanges being cast on to the wall portions 1 in the above-described manner. Prior to the concretesetting, wires 24 have additionally been anchored in the flanges 22. For the purposes of assembling two wall portions 1 with flanges 22, use is made of a tubular intermediate portion 33 which may also comprise concrete. The wires 24 are passed from both sides through the bore formed by the tubular intermediate portion 33, drawn outwardly and then twisted together in a tensioned condition, thereby bracing the wall portions 1 towards each other, and into firm contact with the intermediate portion 33. Openings 25 provided at the edge of the intermediate portion 33 permit the wires to be easily taken out of the intermediate portion.

In the embodiment shown in Figure 9 metal strips 26 have been anchored in the flanges 22. Two wall portions 1 with flanges 22 are then connected together by way of the strips 26. For example screws or wires are passed through bores 27 in the respective strips 26 to make the connection therebetween, or the connection may be produced by spot welding. It is possible to incorporate an extension portion 28 which also has bores 27 in order to increase the spacing between and thus the internal width of the formwork

assembly.

Figure 10 is a diagrammatic view of a configuration of a corner connection, Figure 10a showing the first layer of formwork assemblies and subsequent layers which are odd-numbered layers, while the right-hand part of Figure 10, as indicated by b, shows the second layer of formwork assemblies and subsequent even-numbered layers. In Figure 10a the inner wall portion 1, in the region of the left-hand intermediate portion 20, has been provided with a cut-out or opening 29 which goes to the bottom of the flange 12. When the formwork is subsequently filled with concrete, that provides a connection in respect of the construction concrete with the flange 12 and thus generally gives a continuous concrete wall structure which extends in an integral construction through the corner, without having any interruption by virtue of the presence of a hard foam wall portion 1 in the body of the concrete, so that the construction can represent a fire-proof wall. A similar configuration applies in respect of the next upward layer as shown in Figure 10b in which there is also an opening 29 to provide for a continuous run of concrete through the corner configuration.

Figure 11 shows a wall junction with alternate layers, indicated respectively by Figure 11a and Figure 11b. In this construction once again openings 29 provide for a continuous

run of concrete in the wall structure. A continuous concrete core configuration of that nature not only prevents sound bridge effects and reduces the risk of fire striking through the wall, but in addition it can withstand a higher static loading.

It will be noted that Figure 10 also shows an end part 30 which is secured between the wall portions 1 as by adhesive and which closes off the formwork assembly relative to the exterior. A similar part is indicated at 30 in Figure 11b, closing off the structure between the ends of the wall portions 1.

It will be seen from the foregoing that the above-described process for the production of formwork assemblies for an encased concrete construction system is such that it reduces the production cost and also provides an improved, less expensive formwork assembly which is more capable of withstanding the loadings to which it is to be subjected. It will be appreciated that the operation of casting the flanges of concrete or a like material is substantially simplified because the concrete can be introduced downwardly into the comparatively large opening which defines the subsequent surface connecting the connecting member to the wall portion associated therewith. The moulds can be readily re-used and the templates ensure good dimensional accuracy and reproducibility of the formwork assemblies.

A particular advantage of the formwork assemblies produced by the above-described process and the modified forms of the process as set out below is that it is possible to use smooth wall portions which are cut from a block of for example and preferably hard foam material, without involving the use of grooves or other recesses or retaining configurations. There is no need to use expensive injection moulds and such formwork assemblies are therefore inexpensive and may be built up like for example hollow building blocks. The comparatively high inherent weight of the concrete connecting members ensures adequate stability even in respect of walls which are the height of a storey, which can then be filled with normal or light-weight concrete. Likewise the weight of the concrete connecting members prevents the formwork assemblies from floating up when they are filled with light-weight concrete. If the arrangement is to provide an additional safeguard against the effects of for example wind or stormy weather, the superposed formwork assemblies may be joined together by adhesive means for example, before they are filled with concrete.

In a modified form of the process for the production of a formwork assembly for the encased concrete construction system, wherein the assembly comprises the first and second wall portions and at least one connecting member of concrete or concrete-like material for

connecting the wall portions together, with the or each connecting member being of a generally dumbbell-like configuration providing flange means for fixing to the mutually oppositely disposed wall portions, and an intermediate portion between the flange means, mould halves which are generally of an internal contour corresponding to half of an axially divided dumbbell-like connecting member are filled with concrete or concrete-like material and smoothed off along the plane of separation in respect of the axially divided connecting member. Then the first and second mould halves required to make up a complete mould are fitted together with said planes towards each other. After the material has at least partially set, the mould halves are removed and the connecting members are secured adhesively to the first and second oppositely disposed wall portions, using a bonding agent, in the same general manner as the embodiments of the process described above with reference to the drawings. In this modified form of the process therefore the connecting members of a generally dumbbell-like shape are produced by means of half-mould portions each corresponding to half of an axially separated connecting member. The mould halves may be brought together immediately after the operation of filling them with concrete or like material so that the portions of concrete filling the two mould halves which are brought together

are fixedly interconnected to provide the respective connecting member. It is however also possible, in another feature of this process, to insert a separating agent or material, for example a foil, between the two mould halves, thus producing respective halves of the dumbbell-like connecting member. Those connecting member halves may be used separately, in a condition of bearing against each other or secured together by means of adhesive for example, to produce the formwork assemblies. The operation of filling the mould halves with concrete or like material may be effected by hand or by machine by pouring, shaking, pressing or jarring the concrete into the mould halves. Depending on the particular form of the process used, the concrete or like material is advantageously of a consistency between damp, that is, with a low water content, to liquid.

In still another modified form of that process, the first and second mould halves which are of an internal contour each corresponding to half of an axially divided generally dumbbell-like connecting member are applied against each other in an aligned condition along the plane of separation of the connecting member portions, and are fixedly joined together to form a mould. The mould is put on a flat surface, with its axis extending vertically, and filled with concrete or like material and then, after the concrete material has at least partially set, the mould

halves are removed. The connecting members are secured using a bonding agent to the first and second mutually oppositely disposed wall portions. In that form of the process therefore two axially divided mould halves of the above-indicated kind are used, which however are laid against each other in an aligned condition and are fixedly connected together, for example by clamping or clip means, prior to being filled with concrete or concrete-like material, thereby to form a mould for receiving the concrete or like material. The connection at the edges of the co-operating mould halves may additionally be improved by the provision of a tongue-and-groove configuration. The operation of filling the resulting mould may be effected once again by pouring the material into the mould, shaking it into the mould or pressing it into the mould, both from above and below.

In the two modified forms of the process as described hereinbefore, reinforcing wires may be introduced into the mould or a respective mould half, in a substantially axial position. That provides for a substantial increase in tensile strength of the moulded component, particularly when the wires are profiled and have thickened portions which are welded on to the ends of the wires or which are formed thereon by an upsetting operation or by even simply bending over the ends to provide a hooking engagement portion. Even if the connecting members break for example

during transportation, the wall portions of the formwork assembly still remain joined together by the connection afforded by the wire or wires, which gives a high level of tensile strength.

In those forms of the process the mould halves may be made from any suitable material such as a metal, for example steel plate, or a plastic material.

It will be appreciated that the various above-described forms of processes and formwork assemblies have been set forth solely by way of example and illustration of the present invention and that various modifications and alterations may be made therein without thereby departing from the invention as defined by the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed, are defined as follows:

1. A process for the production of a formwork assembly for the encased concrete construction system, the assembly comprising first and second wall portions and at least one connecting member of concrete or concrete-like material for interconnecting the wall portions, the connecting member being of a generally dumbbell-like configuration providing flange means for fixing to the mutually oppositely disposed wall portions and an intermediate portion between the flange means, including the following steps:

a) a template having openings corresponding to the shape of the flange means is applied to the inward side of a said wall portion,

b) a flowing mortar is introduced into the openings and smoothed off, a bonding agent matched to the material of the wall portion providing for joining the mortar to the wall,

c) moulds corresponding to the flange means to be produced, with their flange-defining opening upwardly, are filled with damp concrete and smoothed off,

d) the moulds are turned over with their flange-defining opening on to the mortar in the openings in the template, and

e) the moulds and the template are removed.

2. A process according to claim 1

wherein f) after setting of the concrete the first and second wall portions are respectively connected by means of the intermediate portions.

3. A process according to claim 1

wherein the bonding agent is mixed with the mortar.

4. A process according to claim 1

wherein the bonding agent is applied to the wall portions in the form of a coating at least in the region of the openings of the template.

5. A process according to claim 4

wherein the bonding agent is applied by dipping of the wall portion.

6. A process according to claim 5

wherein the bonding agent is coloured.

7. A process according to claim 1, 2, 3, 4, 5 or 6, wherein

g) the finished wall portions, with their flange means thereon facing upwardly, are laid out in a layer,

h) an intermediate layer of plate members is laid on the flange means,

i) a further layer of wall portions is laid out on the plate members, and

k) steps (h) and (i) are repeated.

A

8. A process according to claim 1
wherein after removal of th moulds in step (e) the free ends of the flange means are set with a template to a predetermined height.

9. A process according to claim 1
wherein the moulds are of a bell-like configuration in such a way that a stem portion adjoins the respective flange means and the free ends of a pair of said stem portions are adhesively jointed together for connecting two said wall portions in accordance with step (f).

10. A process according to claim 9
wherein prior to setting, at the transition between a flange means and a stem portion, at least one groove-like depression is provided as a subsequent mounting location for a reinforcing rod or bar.

11. A process according to claim 1
wherein the moulds are of such a configuration that the flange means is a disc flange portion, the flange portion is provided with a central depression, and stem-like intermediate portions are adhesively joined to the floors of the respective depressions for connecting two said wall portions in accordance with step (f).

A

12. A process according to claim 11 wherein said central depression is of a circular cylindrical configuration.

13. A process according to claim 11 wherein the stem-like intermediate portion is produced from concrete by means of a cylindrical hollow mould and prior to setting thereof is provided in the region of its two ends with groove-like depressions as subsequent mounting location for reinforcing rods or bars.

14. A process according to claim 1, 2, 3, 4, 5, 6, 8, 9 or 10, comprising embedding extended fixing means into the flange means or the adjoining stem portion prior to setting of the concrete.

15. A process according to claim 14 wherein said fixing means include a reinforcing rod or bar, hook, eye, screw, wire or metal strip.

16. A process according to claim 1, 2, 3, 4, 5, 6, 8, 9 or 10, comprising pressing bores into the flange means or the adjoining stem portion prior to setting of the concrete.

17. A process according to claim 1, 2, 3, 4, 5, 6, 8, 9 or 10, wherein a central separating plate is inserted into the moulds for producing the flange means, the separating plate extending on the axis of the connecting members and in the direction of the height of the formwork assembly so that the finished assembly can be cut off parallel to and in line with the respective separating plates.

A

18. A process according to claim 17 wherein said separating plates are used only in the flange means which are adjacent to the ends of the wall portions.

19. A modified process for the production of a formwork assembly for the encased concrete construction system, the assembly comprising first and second wall portions and at least one connecting member of concrete or concrete-like material for interconnecting the wall portions, the connecting member being of a generally dumbbell-like configuration providing flange means for fixing to the mutually oppositely disposed wall portions and an intermediate portion between the flange means, including the following steps:

- mould halves which are of an internal contour corresponding to half of a said axially separated dumbbell-like connecting member are filled with concrete or like material and smoothed off along the plane of separation therebetween;

- first and second mould halves are brought together with their said planes towards each other;

- after at least partial setting of the material the mould halves are removed, and

- the connecting members are secured to mutually

oppositely disposed wall portions using a bonding agent, to form a formwork assembly.

20. A process according to claim 19 wherein a separating means is disposed between the first and second mould halves before they are brought together.

21. A process according to claim 19 wherein a reinforcing wire is put into one of the mould halves along the axis of the connecting member prior to the first and second mould halves being brought together.

22. A modified process for the production of a formwork assembly for the encased concrete construction system, the assembly comprising first and second wall portions and at least one connecting member of concrete or concrete-like material for interconnecting the wall portions, the connecting member being of a generally dumbbell-like configuration providing flange means for fixing to the mutually oppositely disposed wall portions, and an intermediate portion between the flange means, including the following steps:

- first and second mould halves which are of an internal contour corresponding to half of a said axially separated dumbbell-like connecting member are fitted together in mutual alignment along the plane of separation thereof and fixedly joined together, thereby to form a mould;

- the mould is disposed on a flat surface with the axis extending substantially vertically and filled with concrete-like material;

- after at least partial setting the mould halves are removed; and

- the connecting members are secured to first and second mutually oppositely disposed wall portions, using a bonding agent, to form a formwork assembly.

23. A process according to claim 22
wherein a reinforcing wire is introduced into the mould, along the axis of the connecting member, before the step involving setting of the material and removal of the mould halves.

24. A formwork assembly produced by a process according to claim 1 wherein at least one said wall portion comprises hard foam material.

25. An assembly according to claim 24
wherein a said wall portion comprises gypsum, light-weight gypsum, gypsum-cement concrete or clay.

26. An assembly according to claim 24
wherein the inward side of a said wall portion defines a tongue-and-groove configuration.

27. An assembly according to claim 26
wherein the grooves have undercut portions for improved anchoring of the flange means.

28. An assembly according to claim 24
produced by a process according to claim 14 wherein said flange means are provided with fixing wires which are drawn from both sides through a tubular intermediate portion, and the intermediate portion is provided at both

ends with edge openings through which the wires are guided outwardly and then twisted together in a tensioned configuration.

29. An assembly according to claim 24 including end parts adhesively joined to the ends of wall portions or between the ends of wall portions.

30. An assembly according to claim 29 wherein the end parts of a plurality of formwork assemblies which are disposed in superposed relationship form a unitary plate.

31. An assembly according to claim 24 wherein the wall portions, in the region of the flange means of at least one connecting member, are provided with a slot which extends in a vertical direction.

32. A generally dumbbell-like connecting member produced by a process according to claim 19.

33. A generally dumbbell-like connecting member produced by a process according to claim 22.

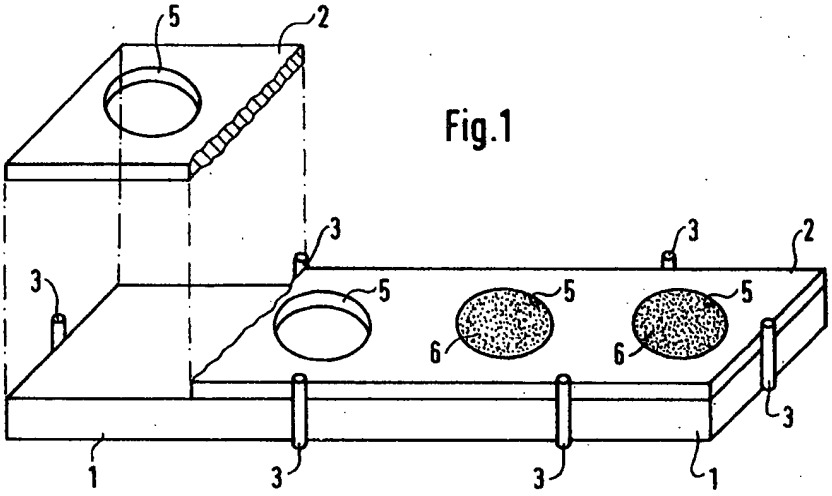


Fig.1

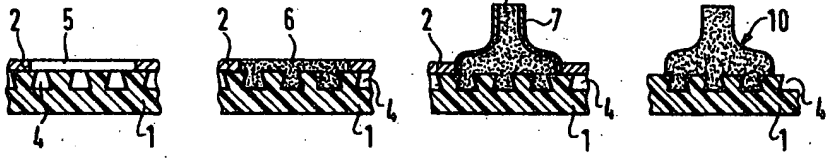


Fig.2a Fig.2b Fig.2c Fig.2d

Kirby, Eades,
Gale, Baker

Fig. 3

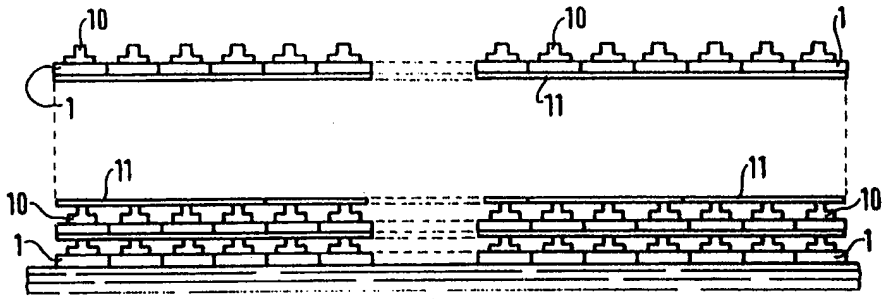


Fig. 4

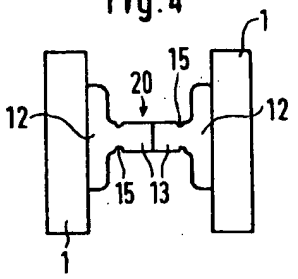


Fig. 5

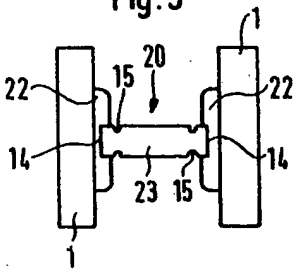
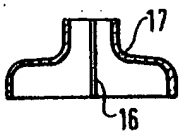


Fig. 6



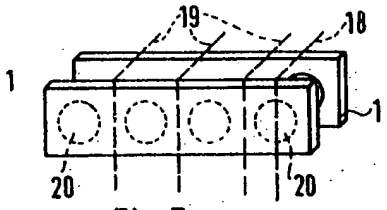


Fig. 7

Kirby, Eades,
Gale, Baker

Fig. 8

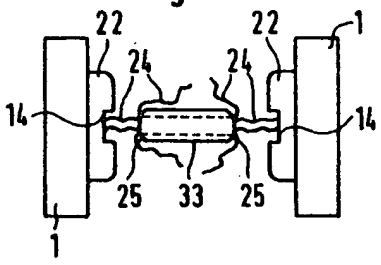


Fig. 9

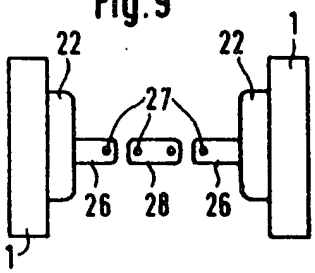


Fig. 10a

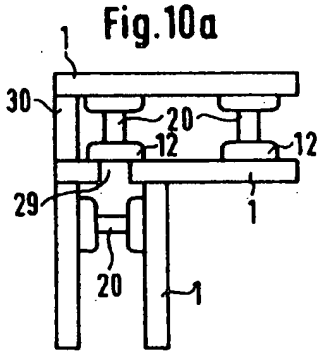


Fig. 10b

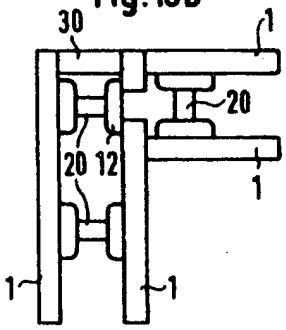


Fig. 11a

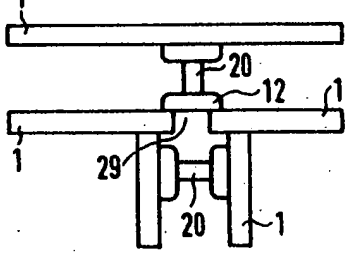
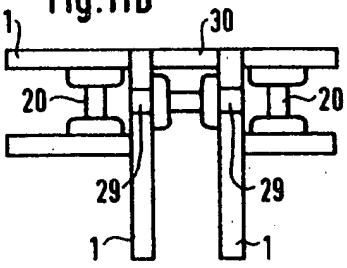


Fig. 11b



Kirby, Eades,
Gale, Baker